

# LIQUID ARGON MEASUREMENT STATUS REPORT

Yichen  
09/24/2013

# **Outlines:**

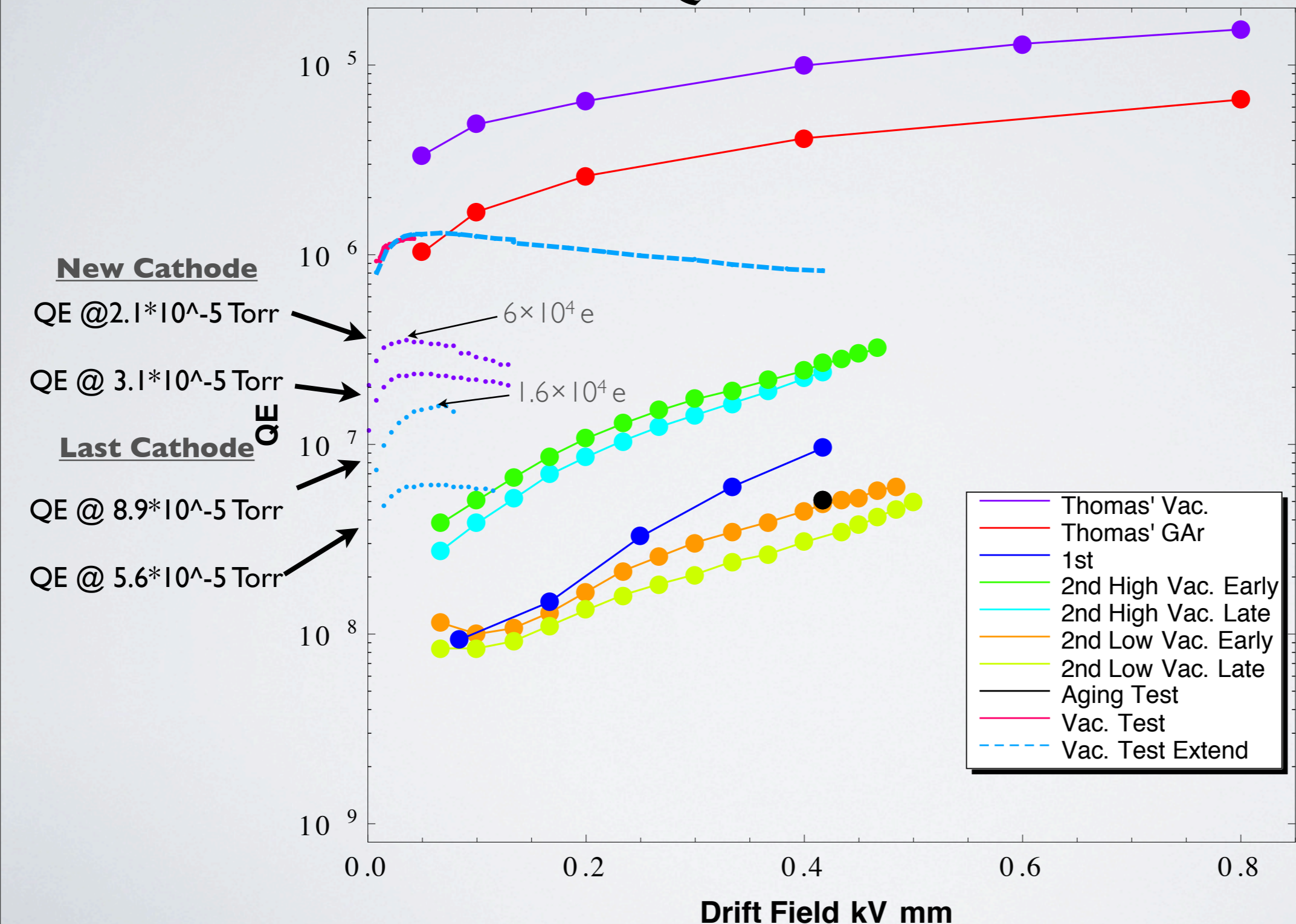
1. Introduction: Status
2. Electron Lifetime Estimation
3. Charge signal measurement in LAr
4. Some issues
5. Summary



# Vacuum QE Results

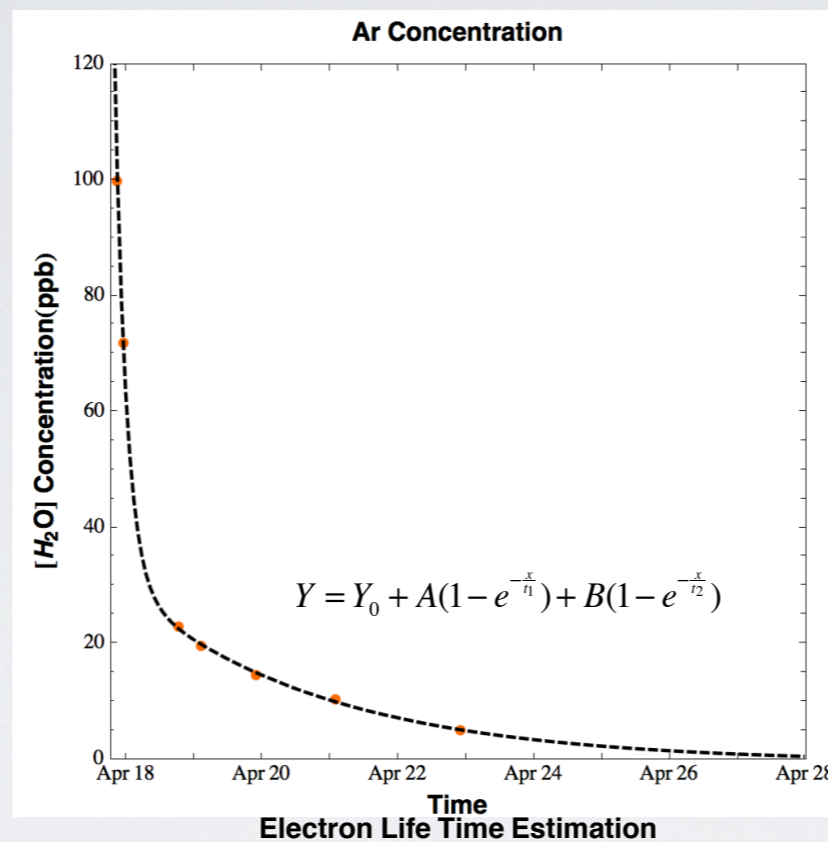
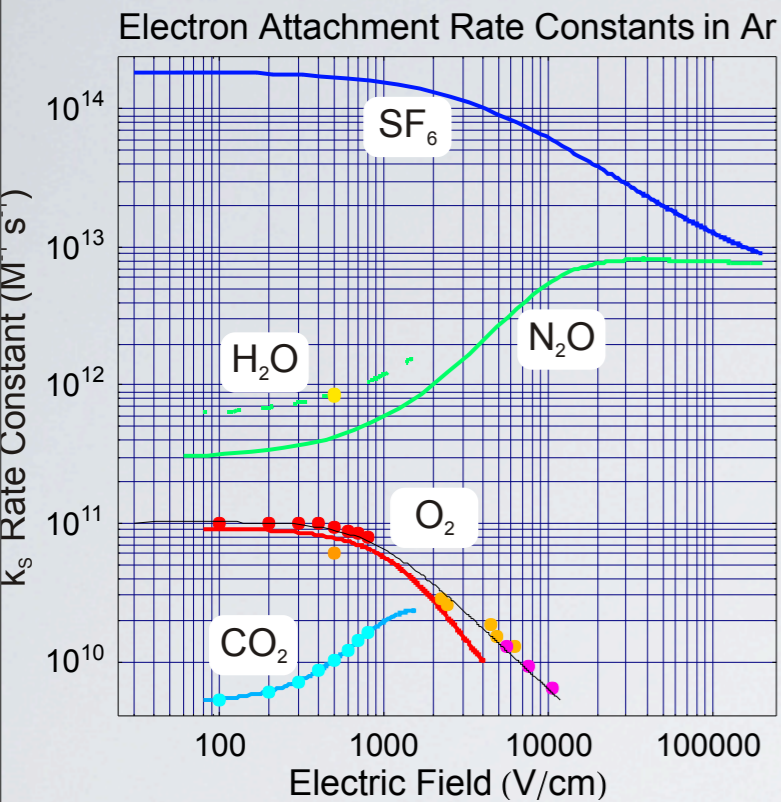
After fixing the leaks, we were able to achieve the best vacuum so far.  
The exposure time of photocathode in the air has been reduced to ~3hrs  
(~3weeks for last photocathode.)

## QE Results



# Electron Life Time Estimation

In order to minimize the loss of Ar by sampling through the monitor, an estimation on electron lifetime is made by considering the attachment.



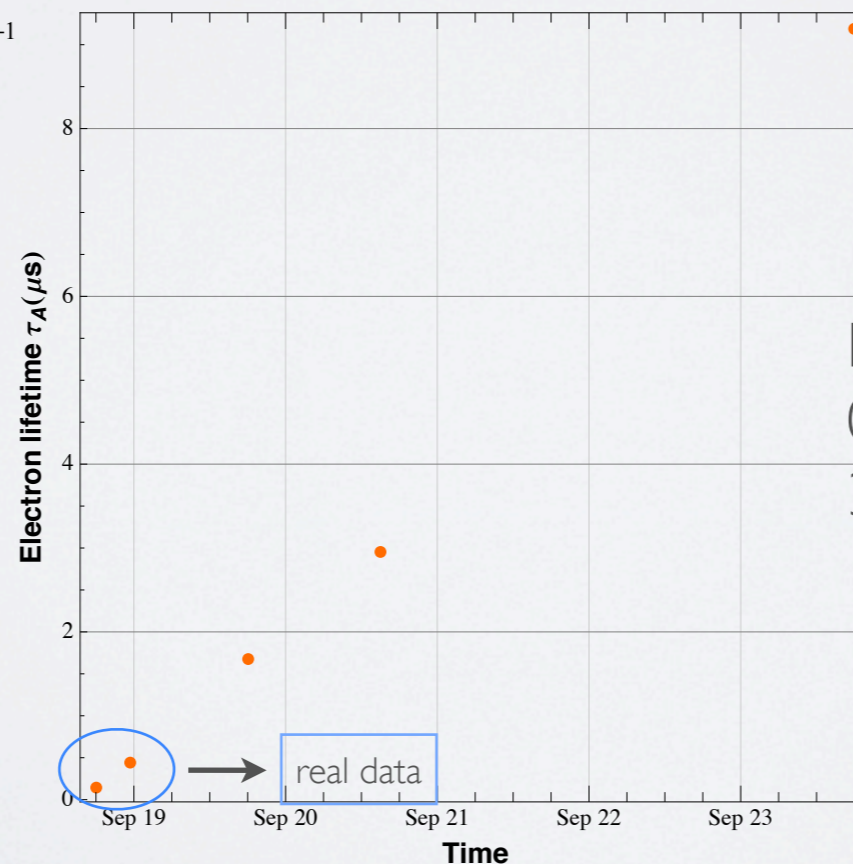
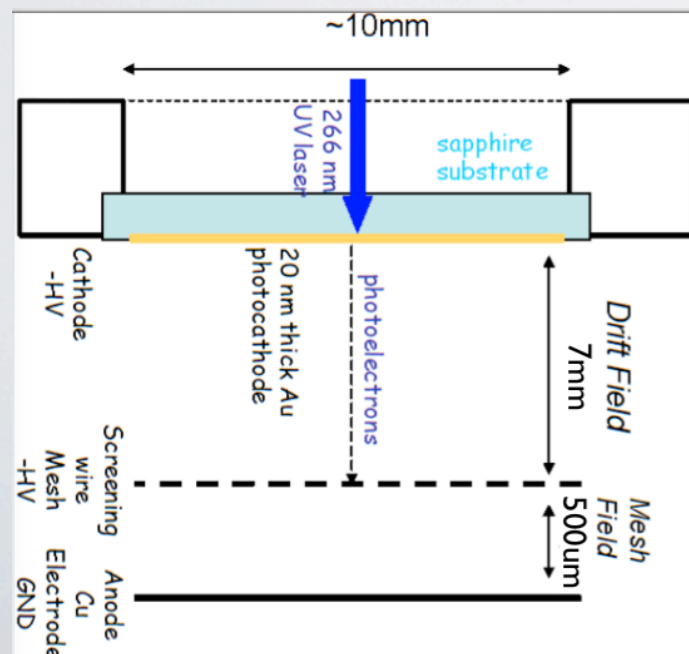
Consider only the attachment by  $H_2O$  at  $0.5kV/cm$ ,  $k_s = 0.8 \times 10^{12} M^{-1} s^{-1}$ ,  
Using the LAr cleaning curve acquired in the engineering run and the moisture value taken at the beginning, the electron life time is estimated.

$$Q(t) = Q_0 \text{Exp}(-t / \tau_A) \text{ with } \tau_A = (k_s n_s)^{-1}$$

$k_s$  is electron attachment rate constant in  $M^{-1} s^{-1}$

$n_s$  is molar (M) solute concentration in LAr

$$1 \text{ M} = 2.503 \times 10^{-8} \rho_{LIQUID}(T) \times \text{ppb}$$



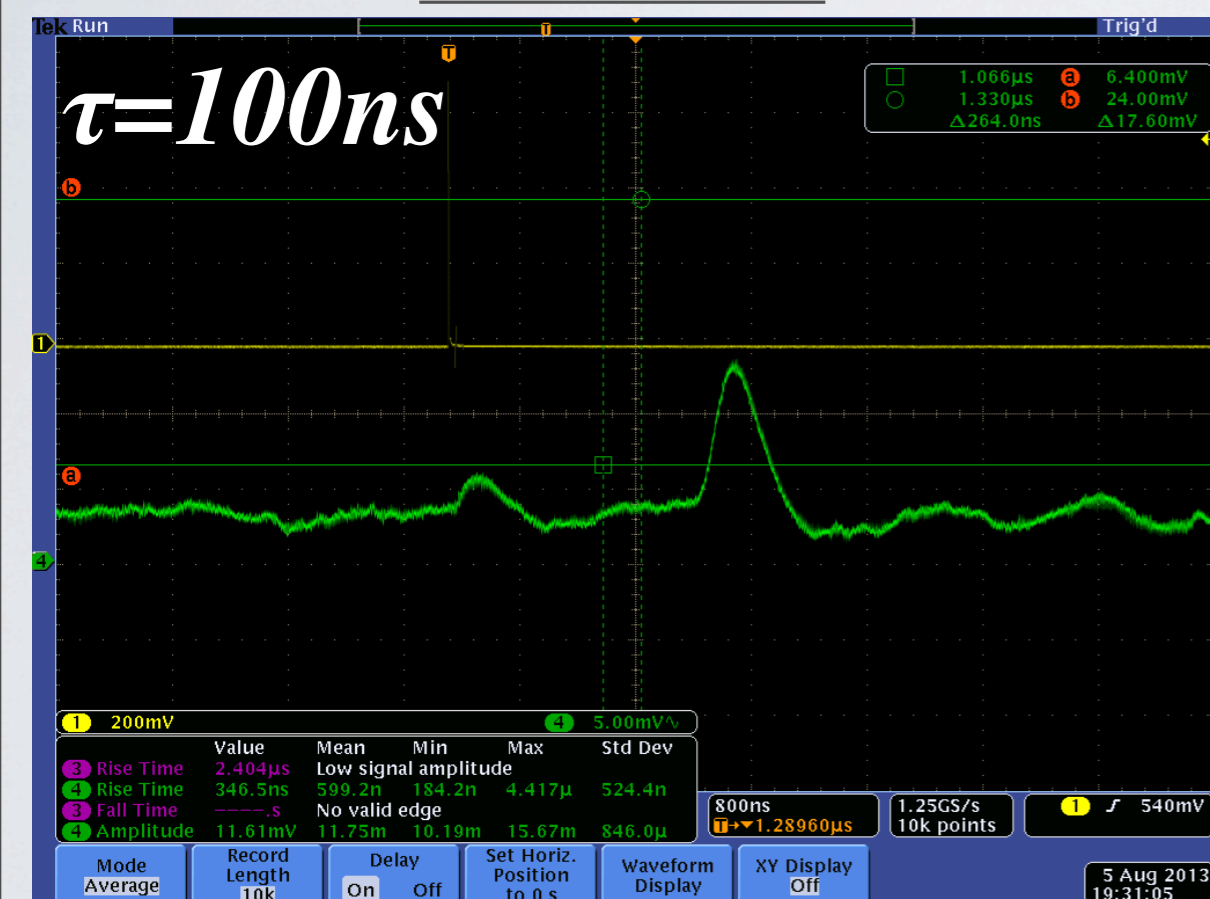
For our drift distance of 7.0mm in LAr,  
 $0.5kV/cm$ ,  $v_e = 1.6mm/us$ , Drift time =  $4.4us$   
 $3.0kV/cm$ ,  $v_e = 3.0mm/us$ , Drift time =  $2.3us$

# Latest Charge Signal Preview

Before going into the details of the latest results of the charge measurement, the charge signal profile with the same shaping time of the previous and the latest measurement are listed to show the improvement.

The laser power  $\sim 1.2\text{mW}$

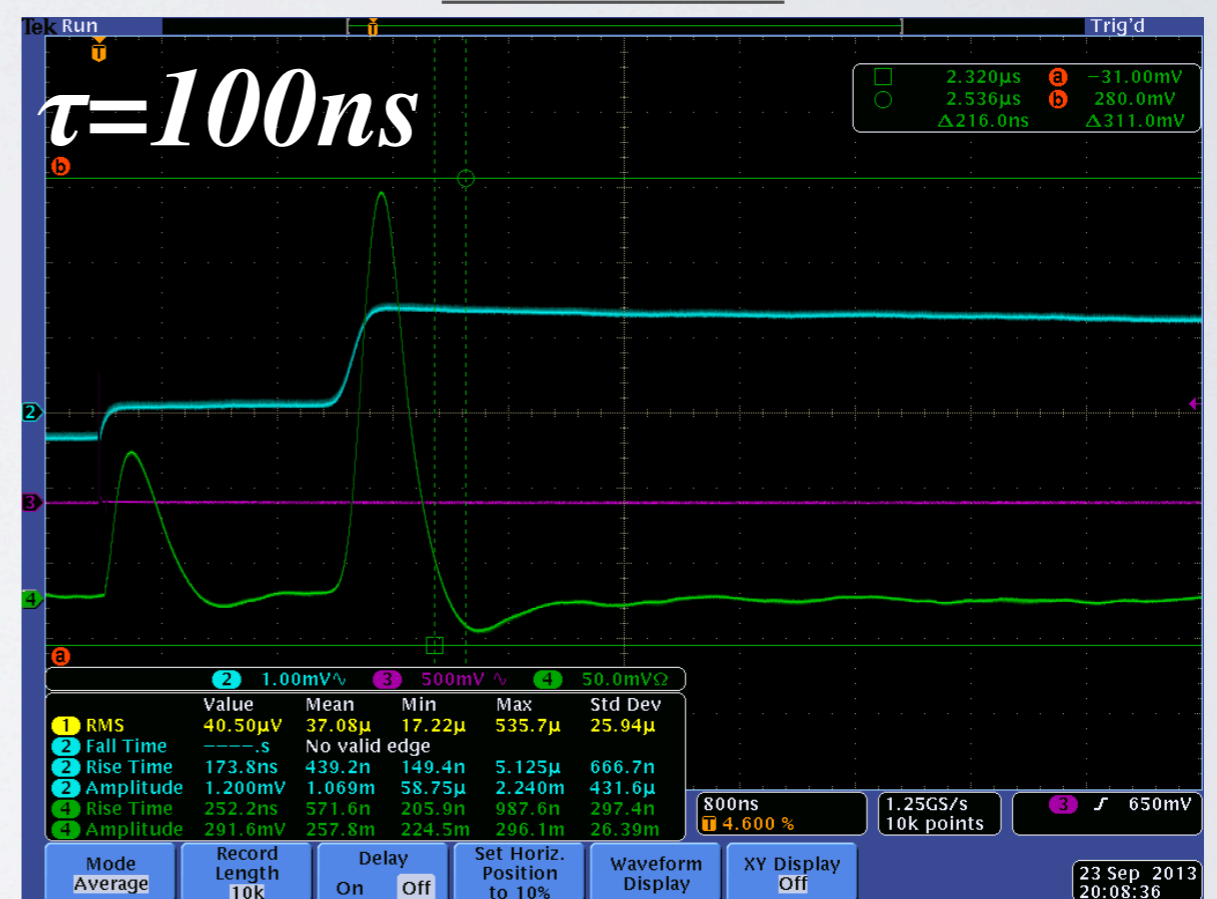
Previous Results



$[\text{H}_2\text{O}] \sim 20\text{ppb}$

Number of electrons  $\sim 3.2 \times 10^3$

Latest Results



$[\text{H}_2\text{O}] \sim 4\text{ppb}$

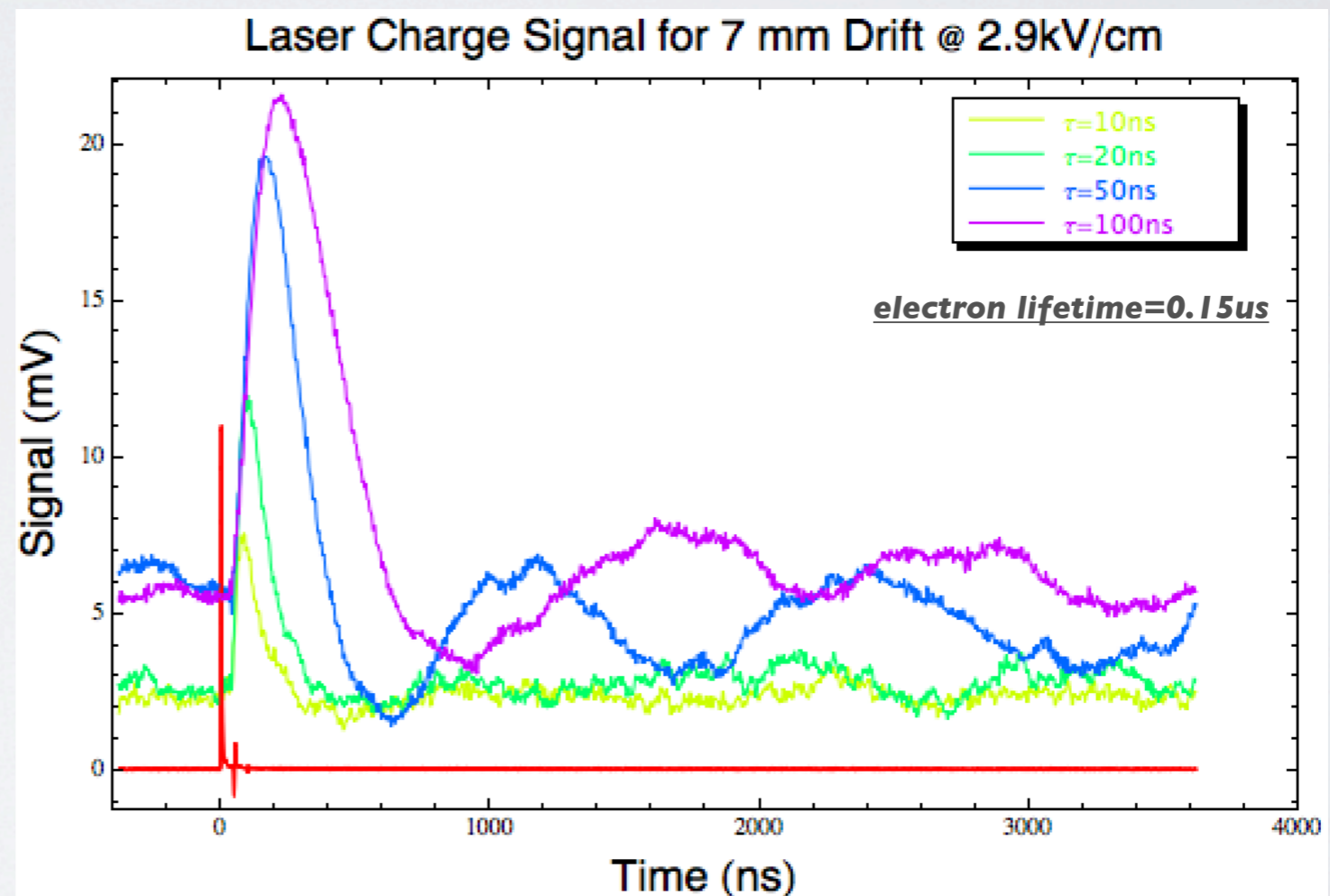
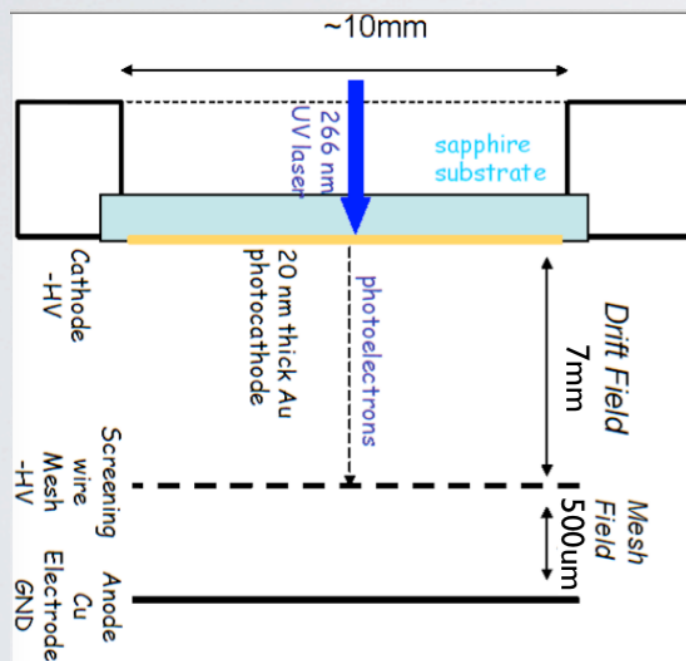
Number of electrons  $\sim 3.6 \times 10^4$

# Charge Signal After Fill

The charge signal was measured right after the fill with LAr.

Drift field= 2.9kV/cm, Mesh field= 10kV/cm

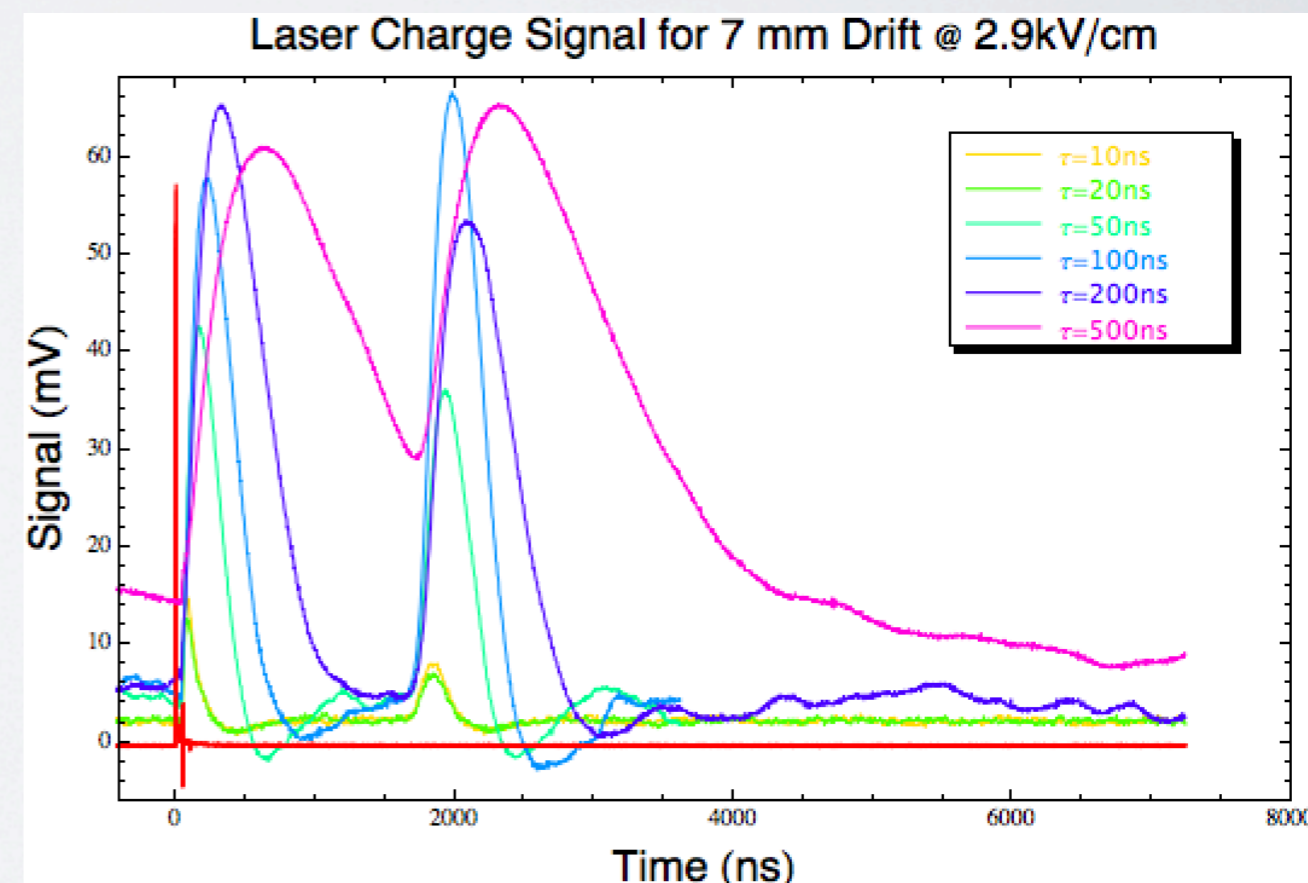
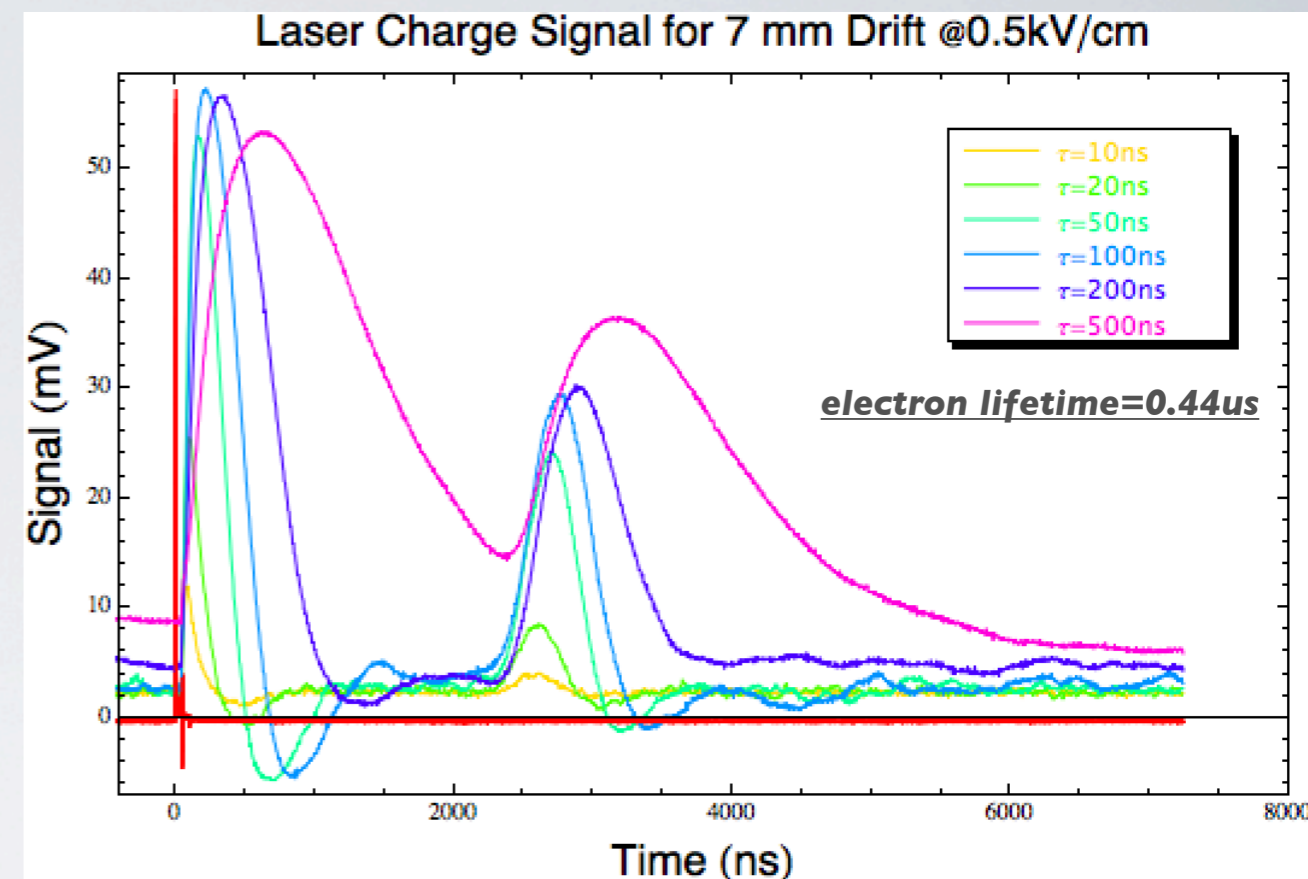
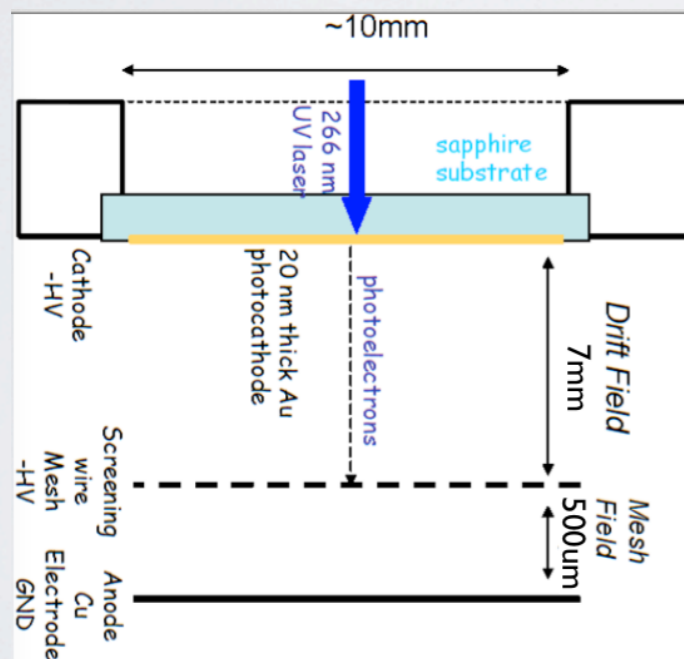
Only the first peak which is the electron emission by the laser on the mesh produced was observed.



# Charge Signal 5 hours After the Fill

~5 Hours after the fill, the electron peak was observed with low amplitude.

Even with 512 frame averaging, the amplitude is not stable.

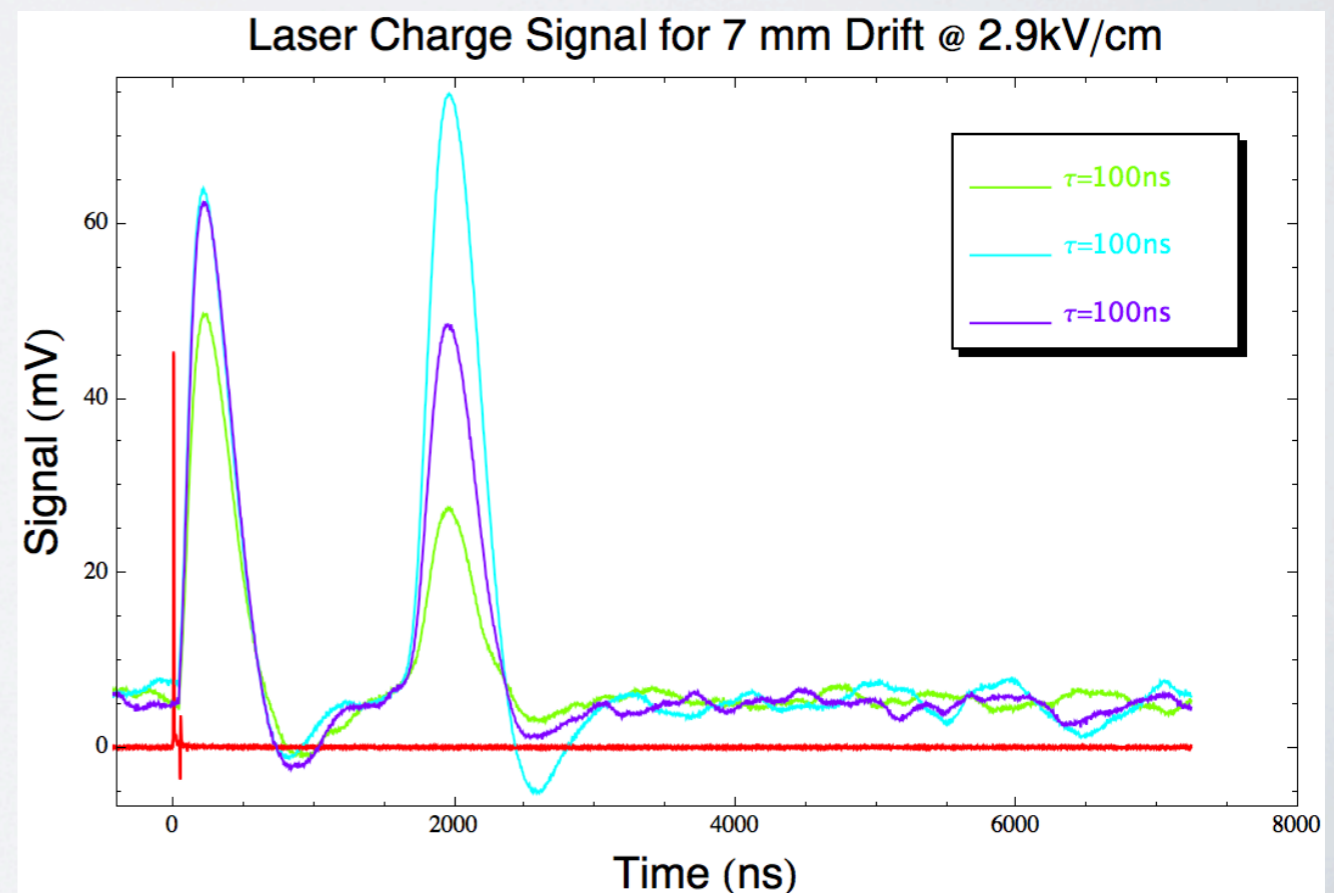
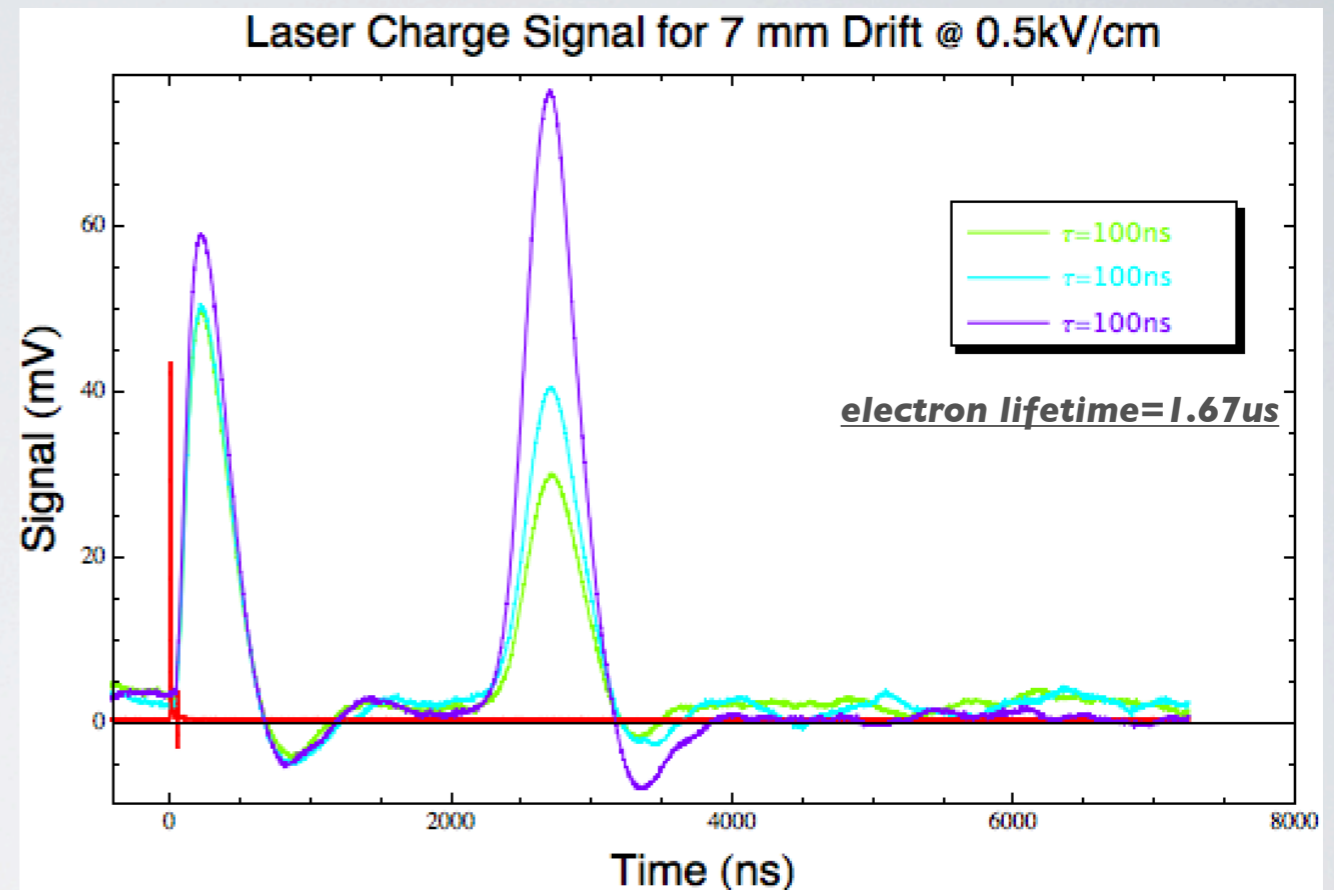
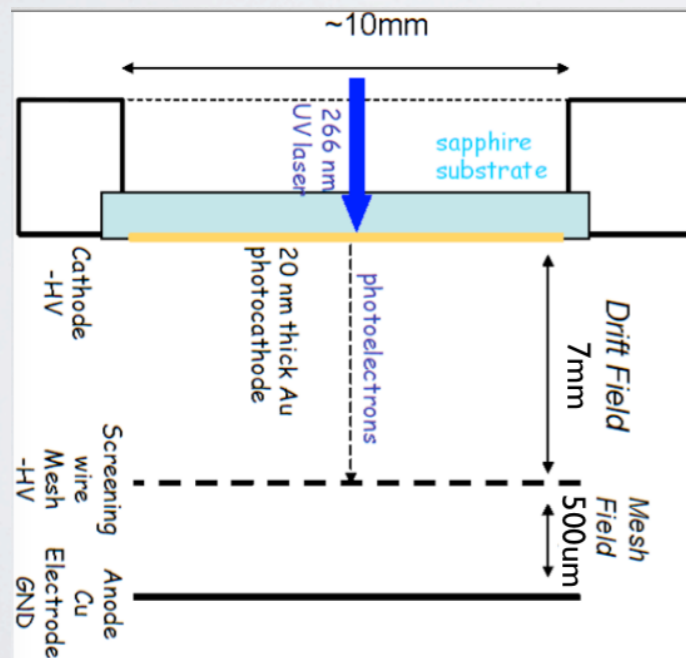


# Charge Signal Amplitude Fluctuation

~24 Hours after the fill, the electron peak amplitude was slightly increased.

The amplitude fluctuation is very obvious.

The plot shows the variation of the amplitude by arbitrarily saving the waveforms with the same shaping time.

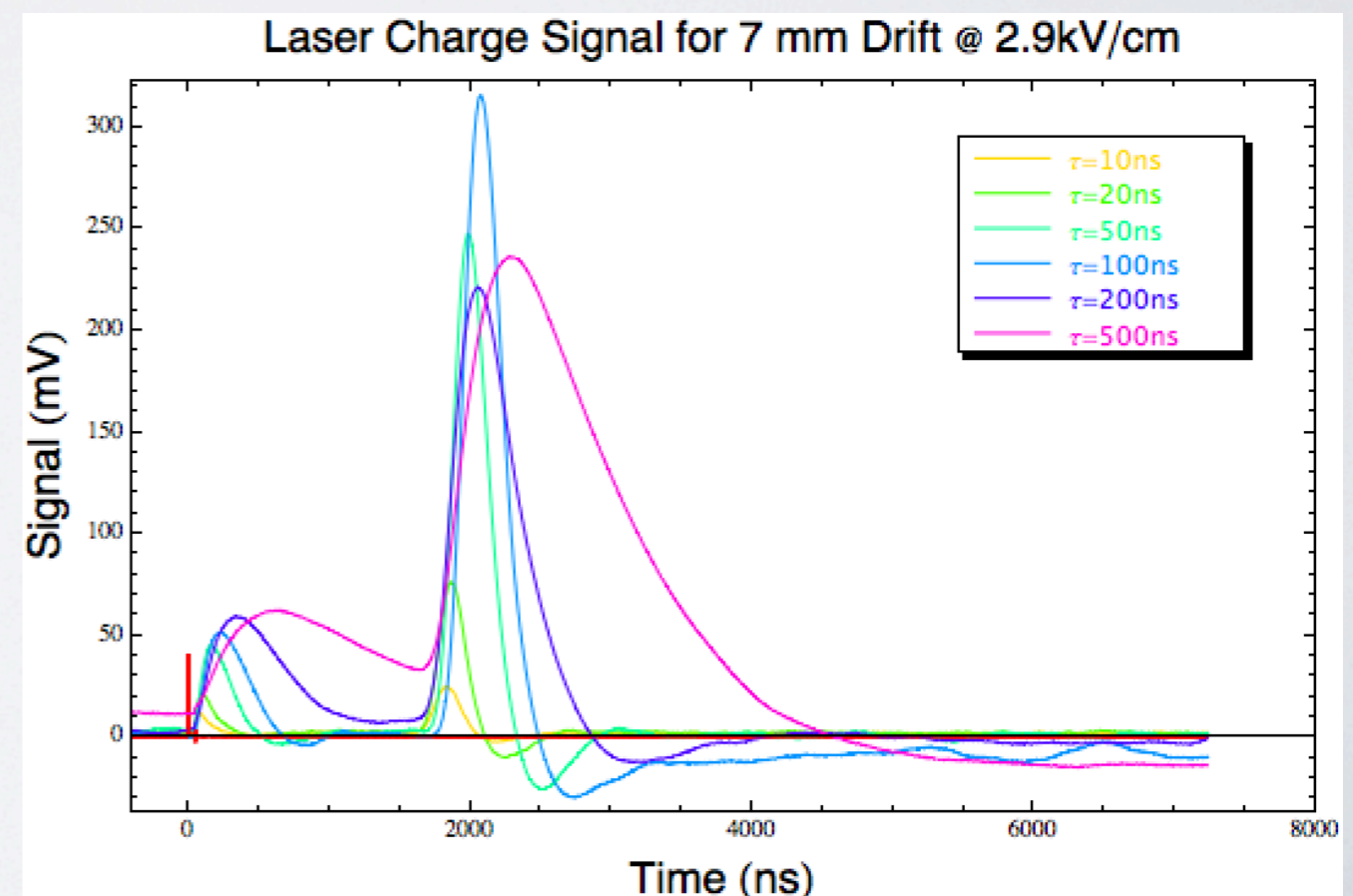
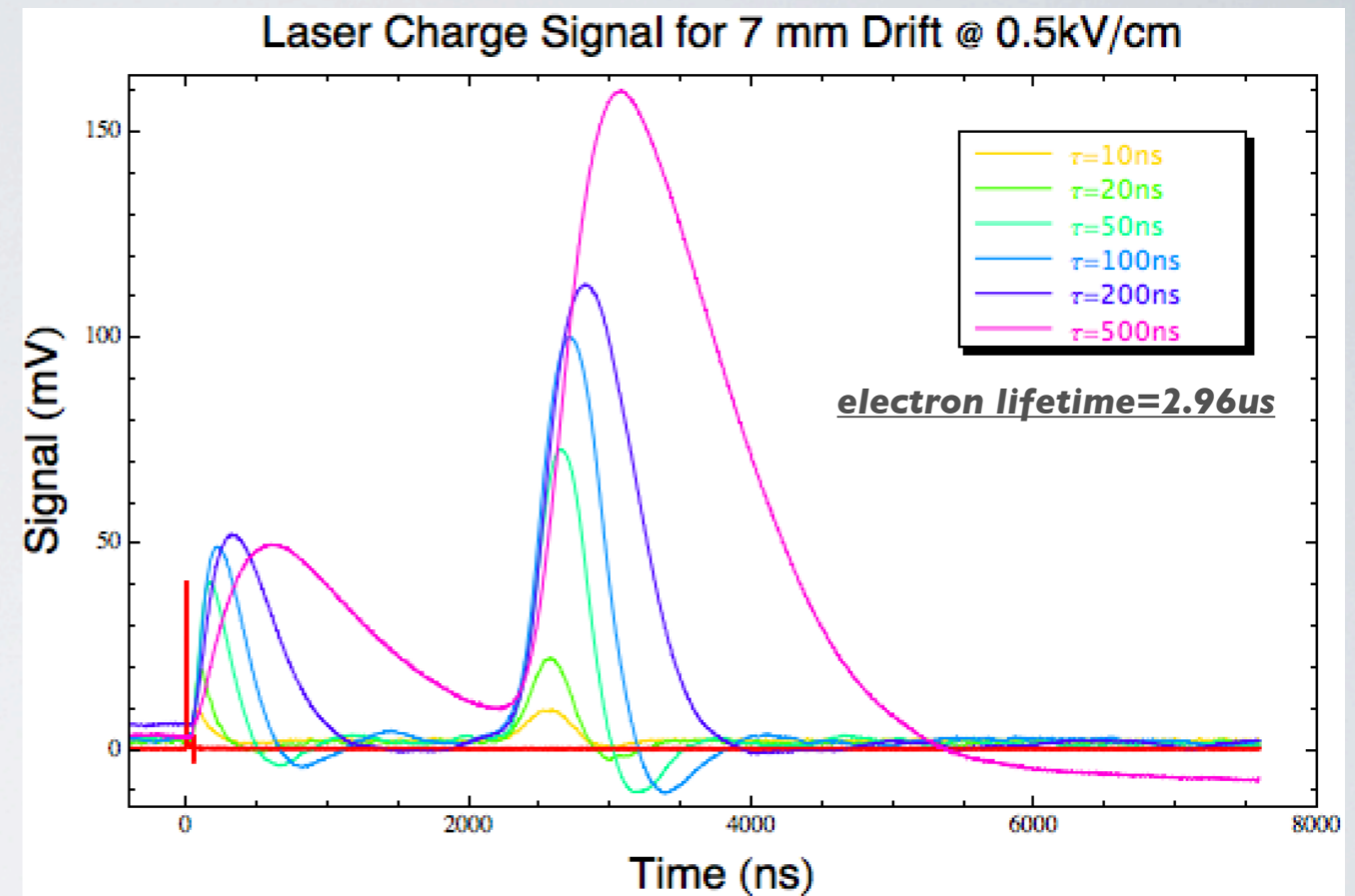
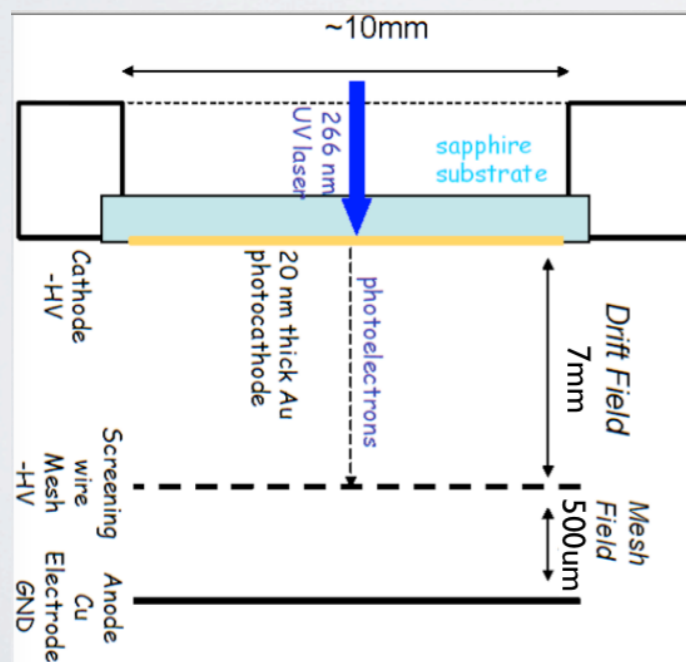


# Charge Signal Amplitude Fluctuation

~72 Hours after the fill, the electron peak amplitude was largely increased.

The amplitude fluctuation was less than previous measurement.

The charge signal amplitude with averaging under 2.9kV/cm field is more stable than under 0.5kV/cm field.



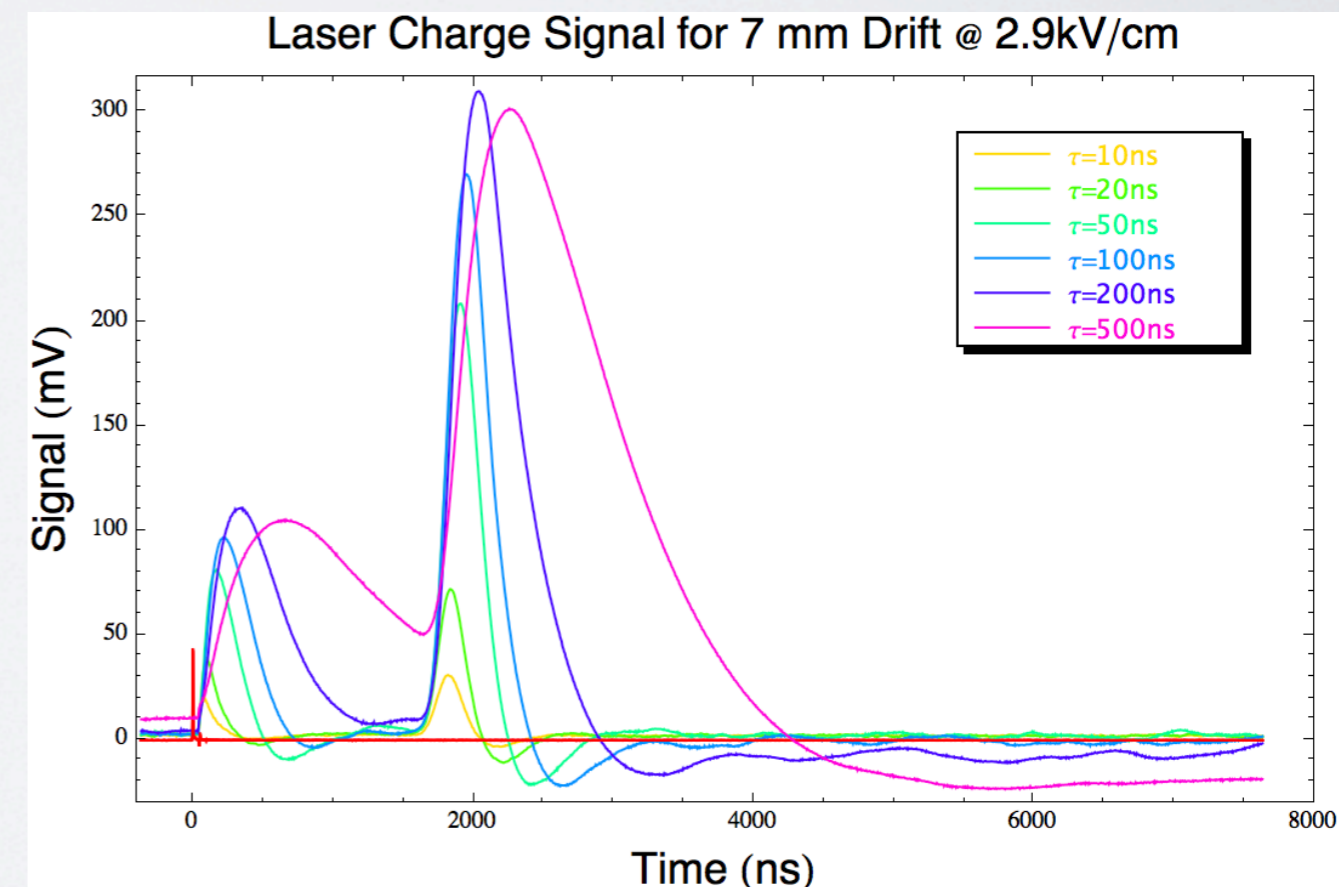
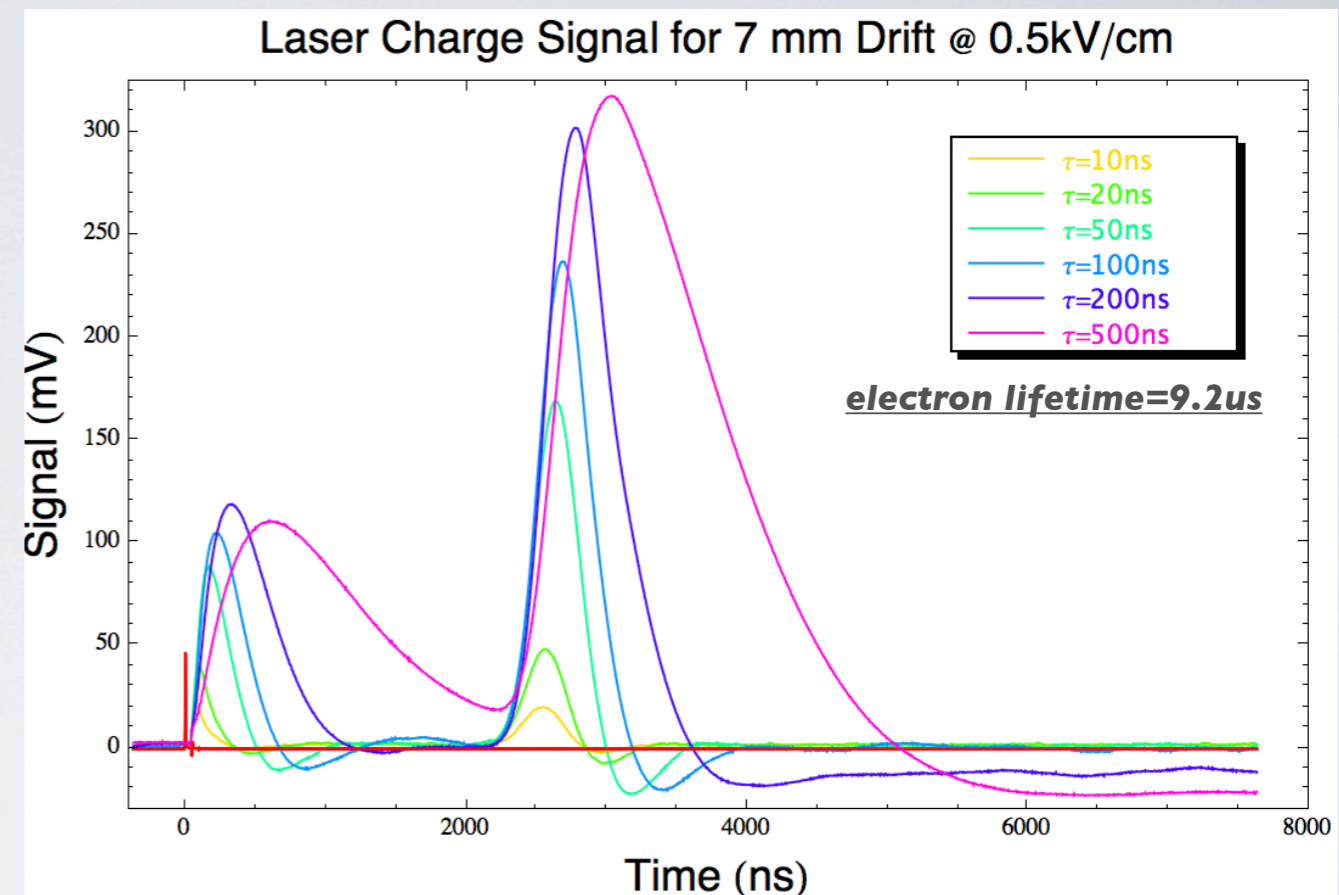
# Charge Signal Amplitude Fluctuation

~144 Hours after the fill, the electron peak amplitude was largely increased.

The amplitude with average is very stable.

The charge signal amplitude with averaging under 2.9kV/cm and 0.5kV/cm are close to each other.

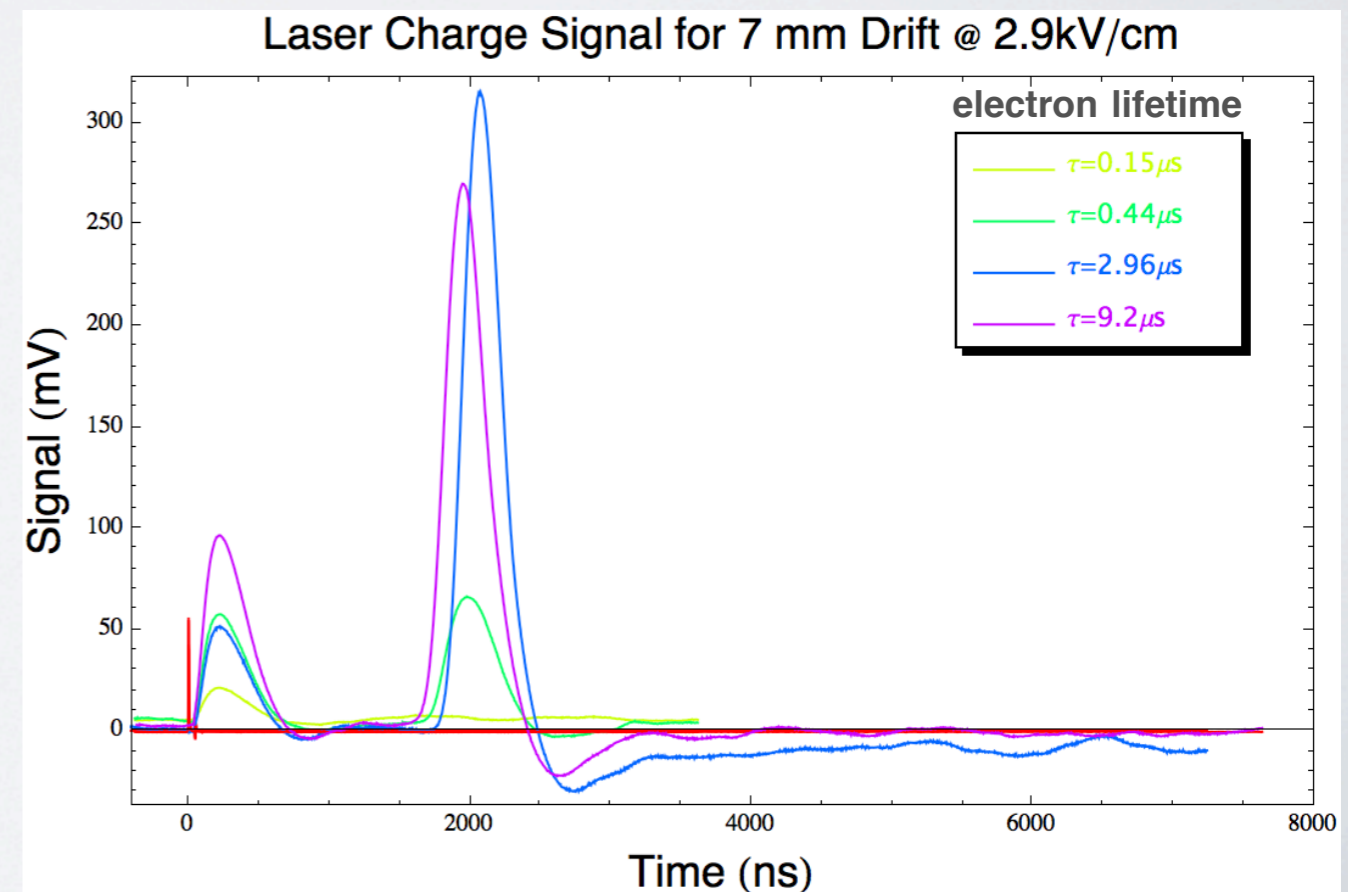
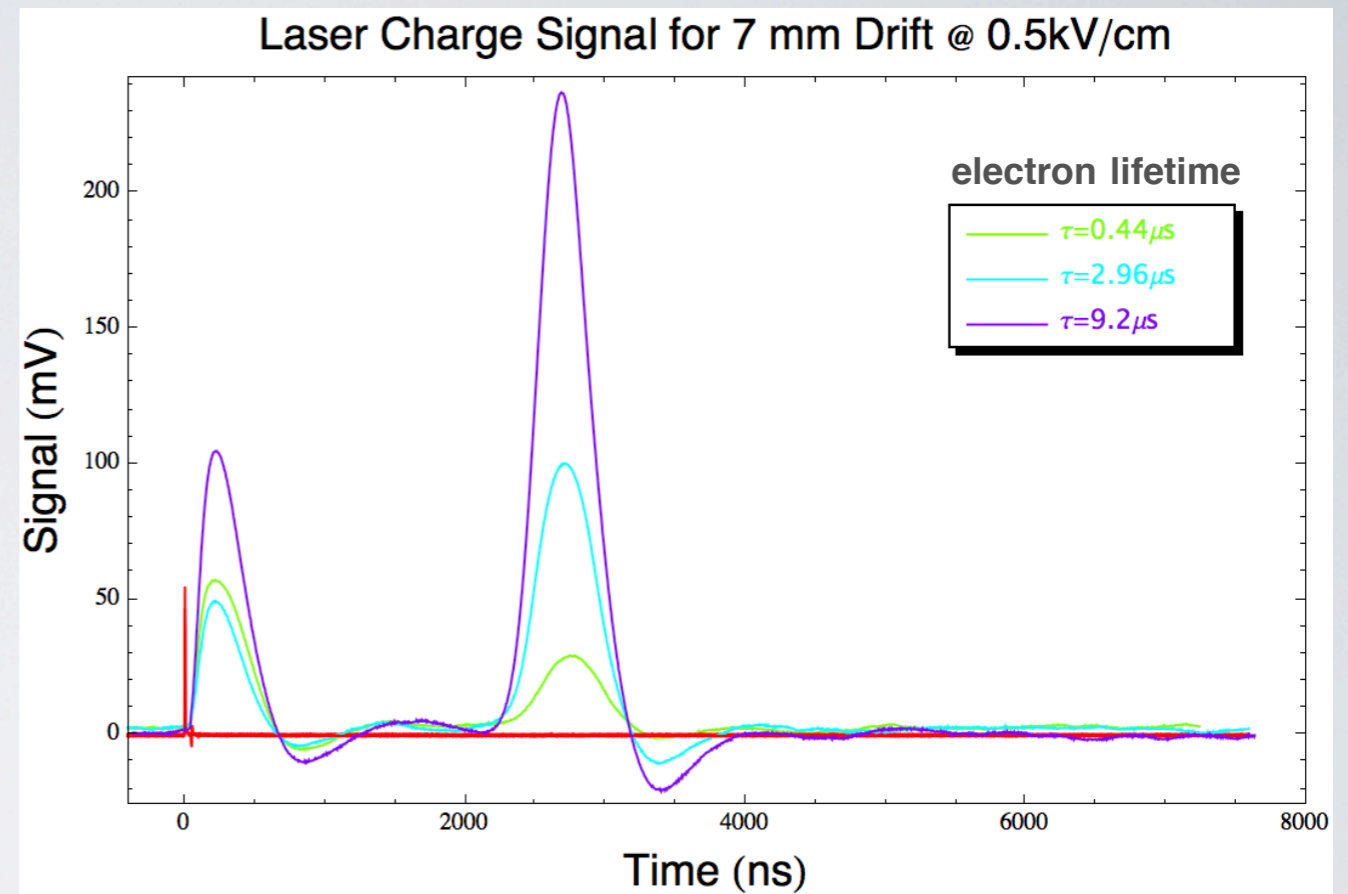
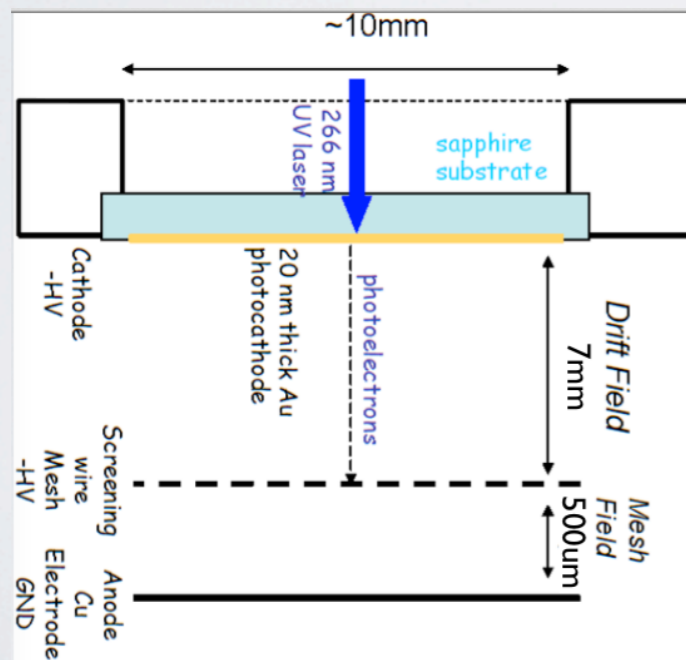
The electron life time is long enough to process the longitudinal diffusion measurement with minimum drift distance



# Charge Signal Amplitude Dependence on Electron Lifetime

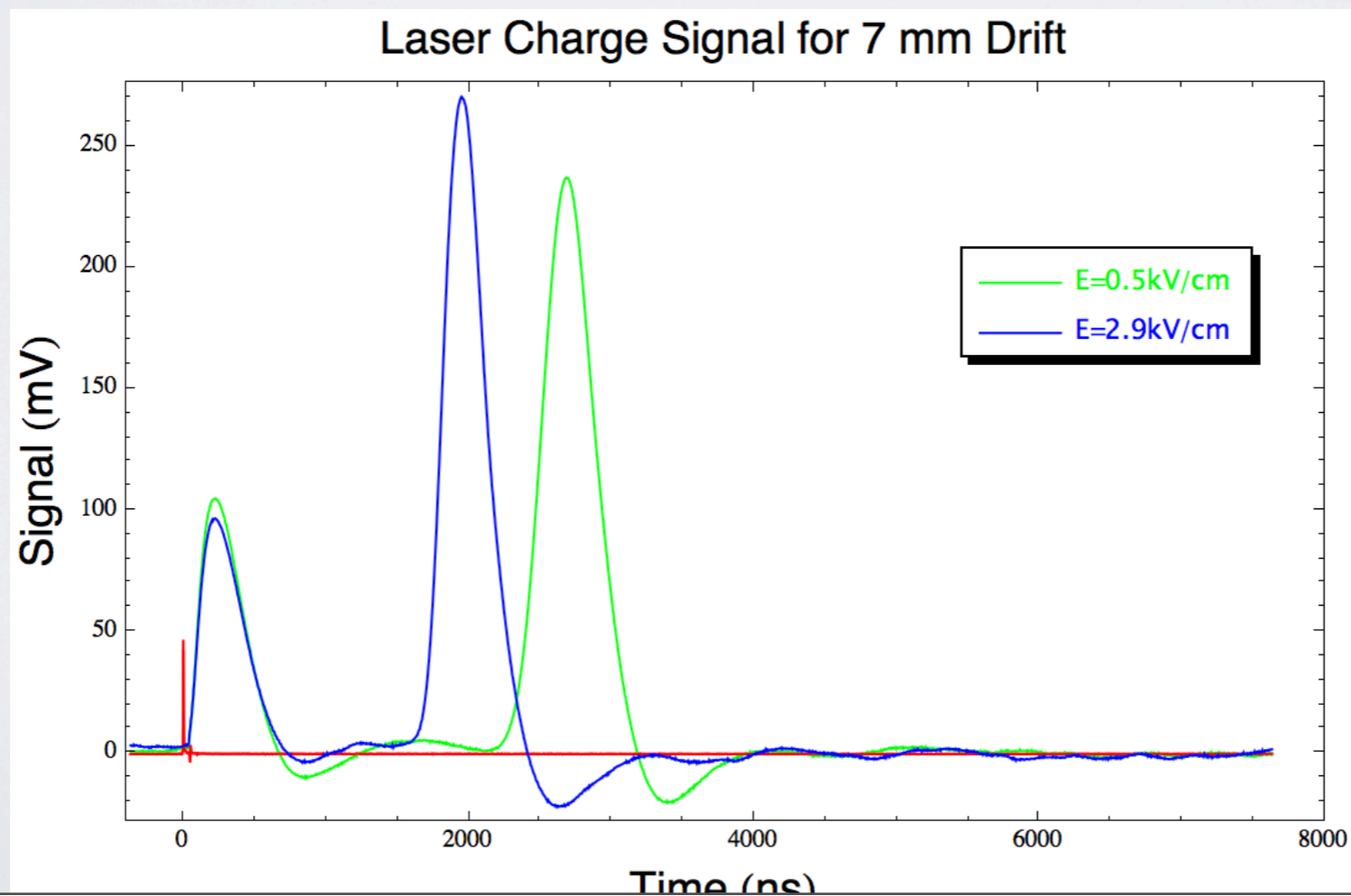
The plots with 100ns shaping time with different electron lifetime are shown to demonstrate the influence of electron lifetime to the signal amplitude.

The maximum number of electrons achieved is  $4.2 \times 10^4$ , which is corresponding to QE of  $\sim 1.01 \times 10^{-7}$ ,



## Some issues

- The UV takes 3-4 hours to warm up to stable working condition and requiring wider TTL pulse.
- The geometric parameters may not be quite accurate, but should be easy to correct.
- Electron peak disappeared with heater on at 50W.
- The measuring range of the drift field. Is 0.25-2.5kV/cm enough?



## Summary

- Charge signal is observed in LAr with new photocathode.
- The signal amplitude and also the SNR is largely improved comparing to the previous results.
- The electron lifetime/LAr purity is sufficient for the longitudinal diffusion measurement with minimum drift distance.
- Data analysis on electron diffusion parameters is in progress.
- Need to order LAr for next fill.